Long Term Resource Monitoring Program Component Database Spatial Query Tool User's Guide

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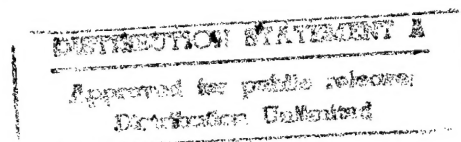*to provide Long Term Resource Monitoring Program partners*
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by

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Preface

The Long Term Resource Monitoring Program (LTRMP) was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. The LTRMP is being implemented by the Environmental Management Technical Center, a U.S. Geological Survey science center, in cooperation with the five Upper Mississippi River System (UMRS) States of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The U.S. Army Corps of Engineers provides guidance and has overall Program responsibility. The mode of operation and respective roles of the agencies are outlined in a 1988 Memorandum of Agreement.

The UMRS encompasses the commercially navigable reaches of the Upper Mississippi River, as well as the Illinois River and navigable portions of the Kaskaskia, Black, St. Croix, and Minnesota Rivers. Congress has declared the UMRS to be both a nationally significant ecosystem and a nationally significant commercial navigation system. The mission of the LTRMP is to provide decision makers with information for maintaining the UMRS as a sustainable large river ecosystem given its multiple-use character. The long-term goals of the Program are to understand the system, determine resource trends and effects, develop management alternatives, manage information, and develop useful products.

This report was prepared under Strategy 2.3.1 Multicomponent Syntheses of the Operating Plan (USFWS 1993). This report was developed with funding provided by the Long Term Resource Monitoring Program.

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Abstract

The Environmental Management Technical Center stores point-sampled data for fisheries, water quality, and invertebrates in a relational database management system. These component data are collected at fixed and random sites in each of the key Long Term Resource Monitoring Program (LTRMP) study Pools: 4, 8, 13, 26, and the open river reach on the Mississippi River; and the La Grange Pool on the Illinois River. While the geographic locations of these data are also collected and stored, the tools to automate the integration of these data with spatial data had not previously been developed. A need existed for an application that would facilitate spatial subsetting and visualization of the distribution of sites meeting certain query criteria. The LTRMP Component Database Spatial Query Tool is a Unix-based ARC/INFO ARC Macro Language application that integrates the component data with spatial data by taking advantage of the graphical display and query capabilities of ARC/INFO. The application features an easy-to-use graphical user interface and requires limited knowledge of Geographic Information Systems (GIS) to use effectively.

Introduction

The Environmental Management Technical Center (EMTC) stores point-sampled data for fisheries, water quality, and invertebrates in a relational database management system. These component data are collected at fixed and random sites in each of the key Long Term Resource Monitoring Program (LTRMP) study Pools: 4, 8, 13, 26, and the open river reach on the Mississippi River; and the La Grange Pool on the Illinois River. While the geographic locations of these data are also collected and stored, the tools to automate the integration of these data with spatial data had not previously been developed. A need existed for an application that would facilitate spatial subsetting and visualization of the distribution of sites meeting certain query criteria.

The LTRMP Component Database Spatial Query Tool

The LTRMP Component Database Spatial Query Tool is a Unix-based ARC/INFO ARC Macro Language application that integrates the component data with spatial data by taking advantage of the graphical display and query capabilities of ARC/INFO. The application features an easy-to-use graphical user interface and requires limited knowledge of Geographic Information Systems (GIS) to use effectively.

The user first selects a study pool and component, zooms to the area of interest, then creates a spatial subset of sampling sites by graphically defining a bounding box or polygon. Next, the user constructs a query and applies it to the spatial subset of sites. Sites meeting or not meeting query criteria can be displayed on the screen, output to a postscript file, or the records meeting query criteria can be output to an ASCII file.

Although the LTRMP Component Database Spatial Query Tool was designed to be as simple to use as possible, it does require a fundamental understanding of GIS concepts and terminology. Also required is a basic understanding of UNIX and the window manager on the host system, basic relational database theory, and an understanding of the LTRMP component database structure and sampling methodologies. These topics will not be covered in this user's guide. For a detailed description of the LTRMP component database structure

and sampling methodologies, see LTRMP Program Report 95-P002 "Long Term Resource Monitoring Program Procedures."

Text Conventions

MAIN MENU BAR OPTIONS are in bold uppercase.

SUB-MENU OPTIONS are in uppercase.

Menu Titles have uppercase first letters.

Starting the Query Tool

To run the application, open a cmdtool window, move it to the lower right corner of the screen, and size it to about 10 dialog lines. Change your directory to "[location_of_install]/integration". Start up ARC, then type "&r start" to launch the application. All user output files will be written to the directory: "[location_of_install]/integration/user_output" (Figure 1).
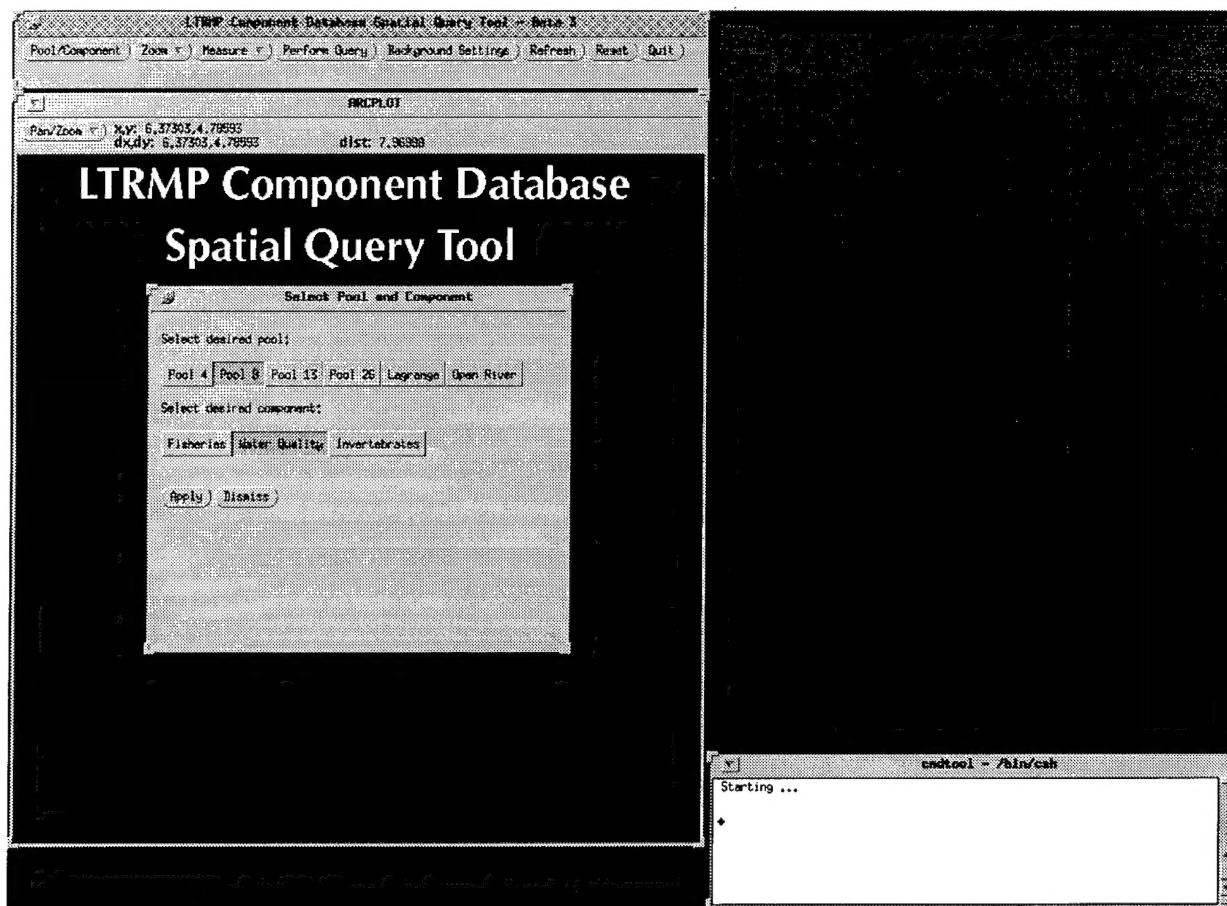

Figure 1. Select pool and component menu.

Overview of the Main Menu Bar

The **POOL/COMPONENT** button will bring up a menu for selecting the desired pool and component.

The **ZOOM** pull-down menu has options for:
ZOOM IN   Zoom in by defining box.
ZOOM OUT   Zoom out from center of current view area.

The **MEASURE** pull-down menu has options for:
DISTANCE   Measure distance along a line.
AREA   Measure area within polygon.
WHERE   Get X and Y coordinate for location.
IDENTIFY   List GIS grid code for sampling site.

The **PERFORM QUERY** button will bring up a menu of options for subsetting spatially, entering logical expressions, and defining output options.

The **BACKGROUND SETTINGS** button will bring up a menu with options for selecting different combinations of background themes.

The **REFRESH** button will redraw the current view.

The **RESET** button will reset the view extent to the entire currently selected pool and clear any spatial or logical subsets.

The **QUIT** button will exit the application.

Using the LTRMP Component Database Spatial Query Tool

Using the application consists of six basic steps:

1. Select Pool and Component
2. Zoom to Area of Interest
3. Subset Sampling Sites Spatially
4. Build Logical Expression(s) to Apply to Spatial Subset of Points
5. Select Output Options
6. Submit Query

1. Select Pool and Component

The Pool/Component menu will be displayed at program startup. Select the desired pool and component then click the Apply button. The selected pool will be drawn in the graphics display window and the pool and component name will be displayed at the lower left. To change pool or component, use the **POOL/COMPONENT** button from the main menu bar (Figure 2).
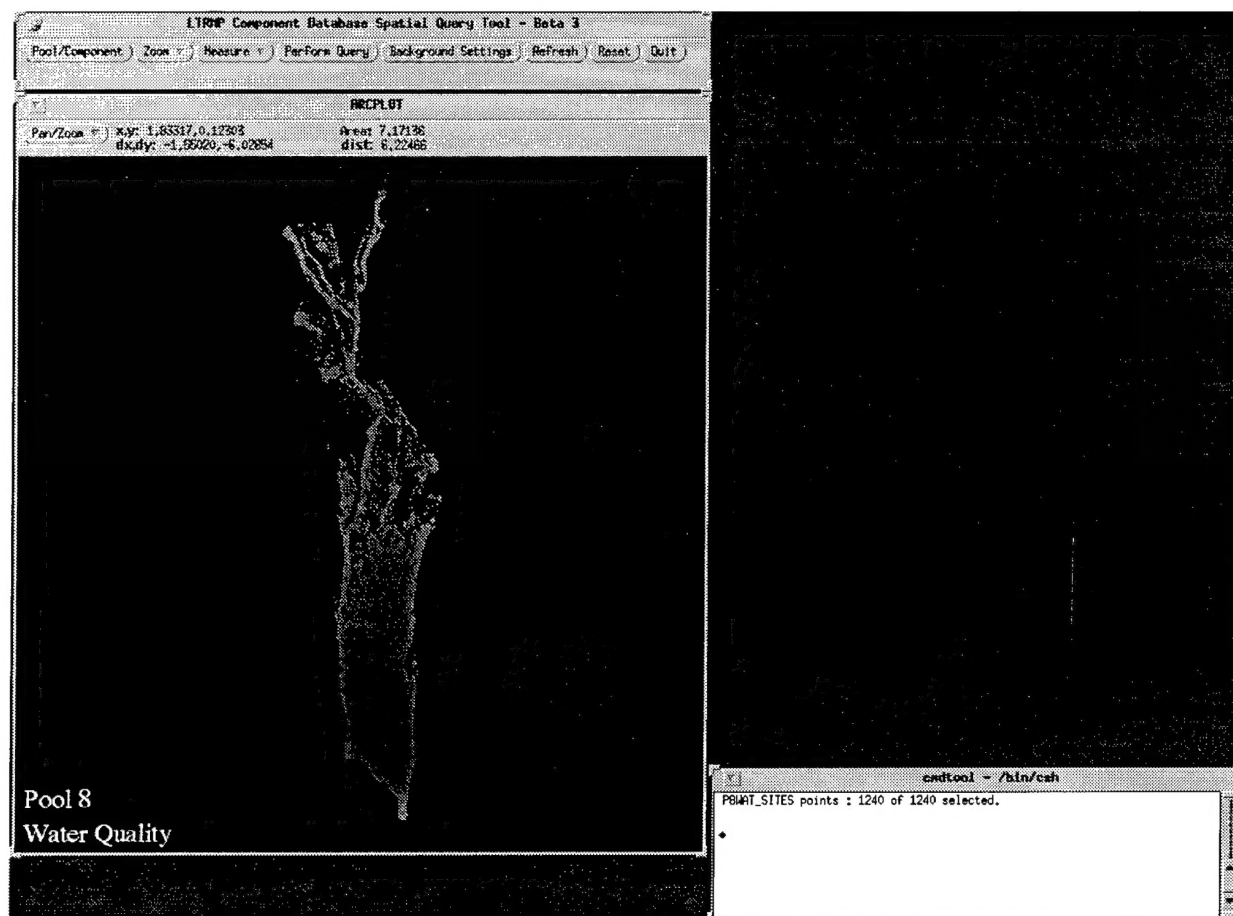
Figure 2. Pool 8 water quality—full pool view.

2. Zoom to Area of Interest

ZOOM IN and ZOOM OUT options are available from the **ZOOM** pull-down menu on the main menu bar. When the ZOOM IN option is selected, you will be prompted from the cmdtool window to define a bounding box for the area you wish to zoom in to. Use the first mouse button to indicate opposing box corners. The ZOOM OUT option will zoom out from the center of the existing view. Use the **RESET** option from the main menu bar to set the view extent back to the entire currently selected pool.

3. Subset Sampling Sites Spatially

Select the **PERFORM QUERY** option from the main menu bar. The Perform Query menu will be displayed with options for subsetting spatially, entering a logical expression, and defining output options. There are two icons under the "Subset Spatially" section; one for defining a bounding box, and one for defining a bounding polygon. When the "box" icon is selected you will be prompted from the cmdtool window to define a box around the sites you wish to include in the spatial subset. Use the first mouse button to indicate opposing box corners. When the "poly" icon is selected, a text-based menu will be displayed in the cmdtool window:

> Define the polygon
> <1,2 to enter, 4 to remove last point, 5 to remove polygon, 9 to end>

Use these options to define a polygon bounding the sites you wish to include in the spatial subset (Figure 3). Note: The defined spatial subset will remain set until specifically changed. Closing the Perform Query menu, using the Zoom options, or changing the logical expression will not alter the spatial subset.
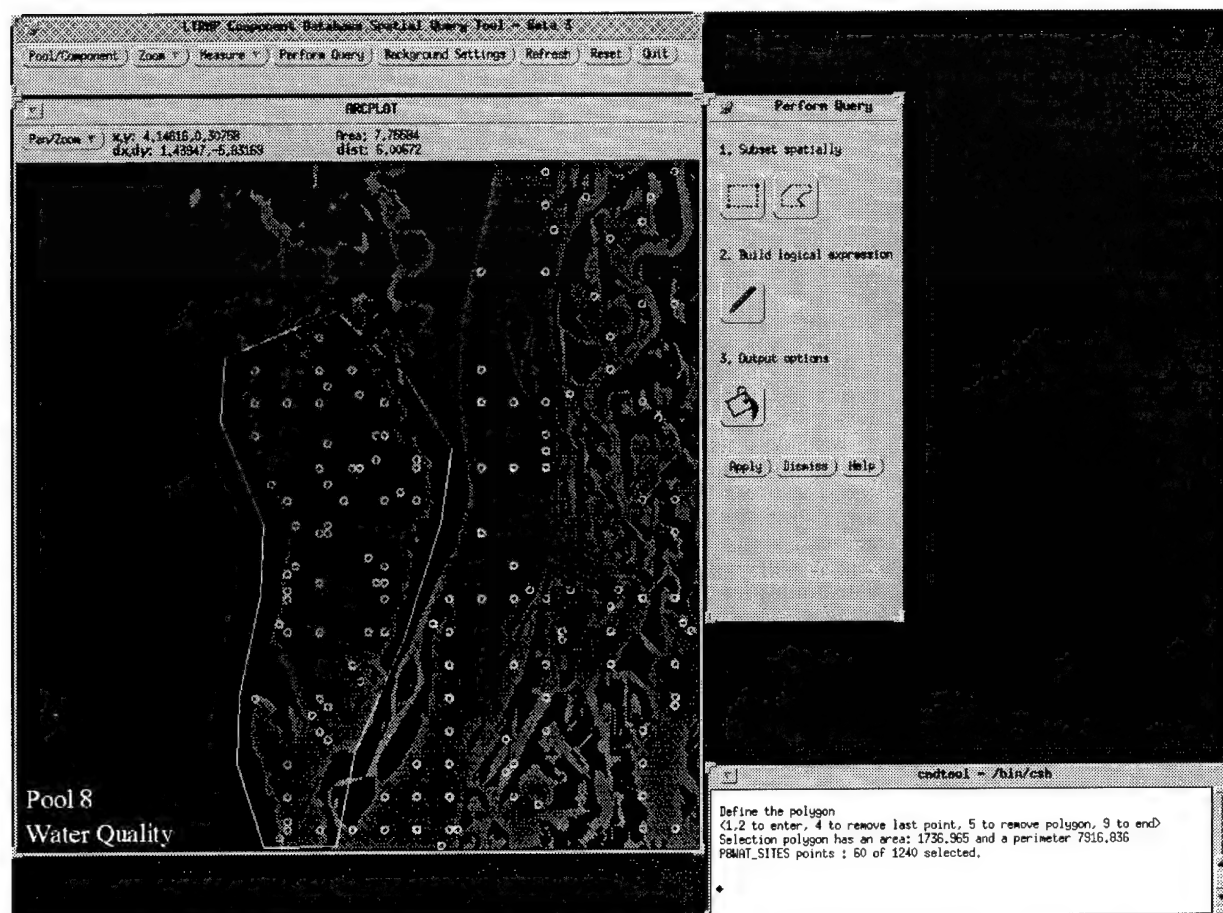

Figure 3. Subsetting sites by defining a polygon around the area of interest.

4. Build Logical Expression(s) to Apply to Spatial Subset of Points

Select the "Build Logical Expression" icon from the Perform Query menu. The Build Logical Expression menu will be displayed with options for building a logical expression to apply to the previously selected spatial subset. A scrolling list of items from the selected component table will be displayed at the top of the menu. Descriptions of the items can be viewed by selecting the "Describe" button. The "Add" button will add the item name from the scrolling list to the logical expression entry line. The buttons for logical operators and operands will add the respective operator or operand to the logical expression entry line (see Appendix for a detailed description on building logical expressions). The "Clear" button will clear the logical expression entry line. The Background Query section pertains to submitting and displaying two queries. See below section, "The Background Query Option", for more information on this option (Figure 4).
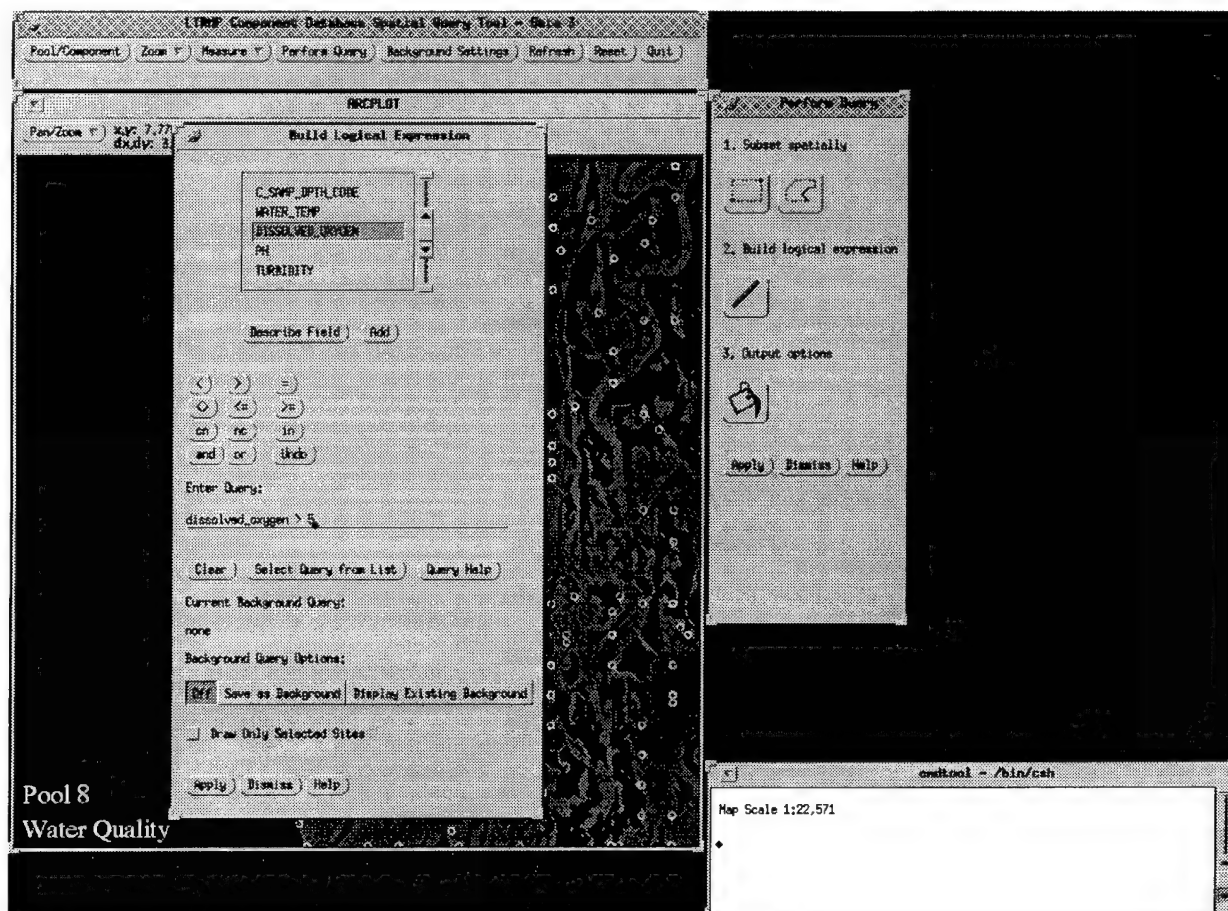
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Figure 4. Entering a query to apply against the spatial subset of sites.

After the desired logical expression has been entered into the logical expression entry line, select the "Apply" button. Note: The defined logical expression will remain active until specifically changed from the Build Logical Expression menu. Closing the Perform Query menu, using the Zoom options, or changing the spatial subset will not alter the logical expression.

The Background Query Option

This option facilitates display of two queries, the second being a subset of the first. This option requires that steps 4 and 6 be executed twice, once to create and save the background query subset of sites and once to enter the secondary query that will be applied to the background query subset of sites. To display and save a background query subset, enter the background query criteria on the logical expression line, select the "Save as Background" option and proceed through steps 5 and 6 (Figures 5 and 6). To enter the secondary query reopen the Perform Query Menu. The previously entered background query should be listed as the "Current Background Query". Enter the desired logical expression to be applied against the background query subset on the logical expression entry line, select the "Display Background Query" option and proceed through steps 5 and 6 (Figures 7 and 8). Selecting "Off" in the Background Query Options section will disable background query functionality. Use the checkbox labeled, "Draw Only Selected Sites", to toggle the display of sites not in the background subset.
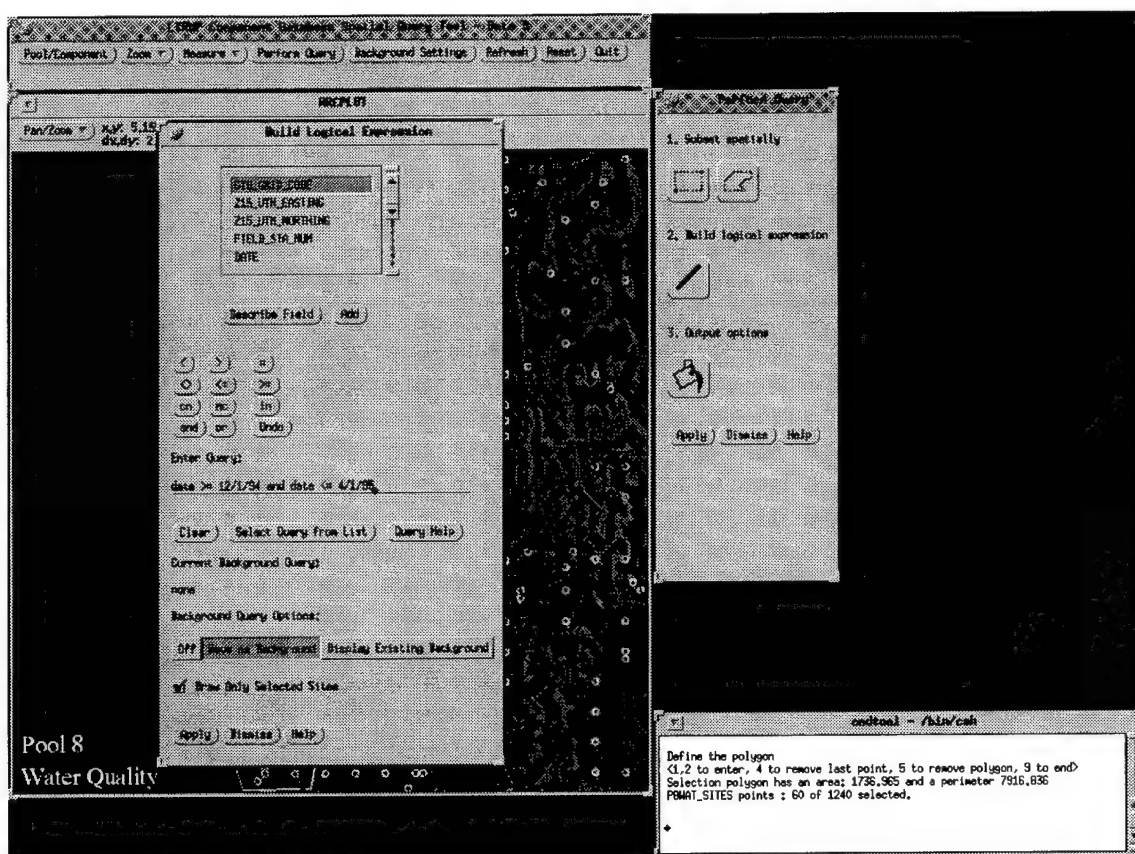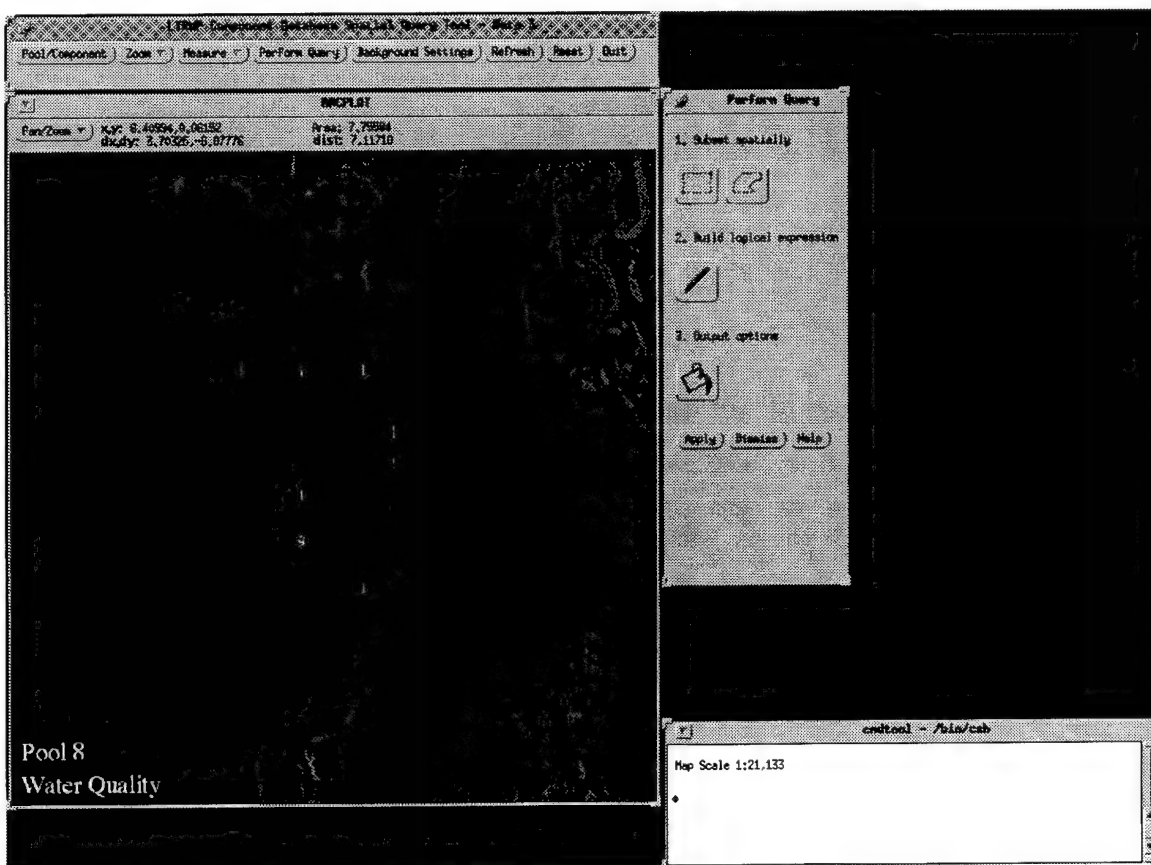
Figure 5. Entering a background query.

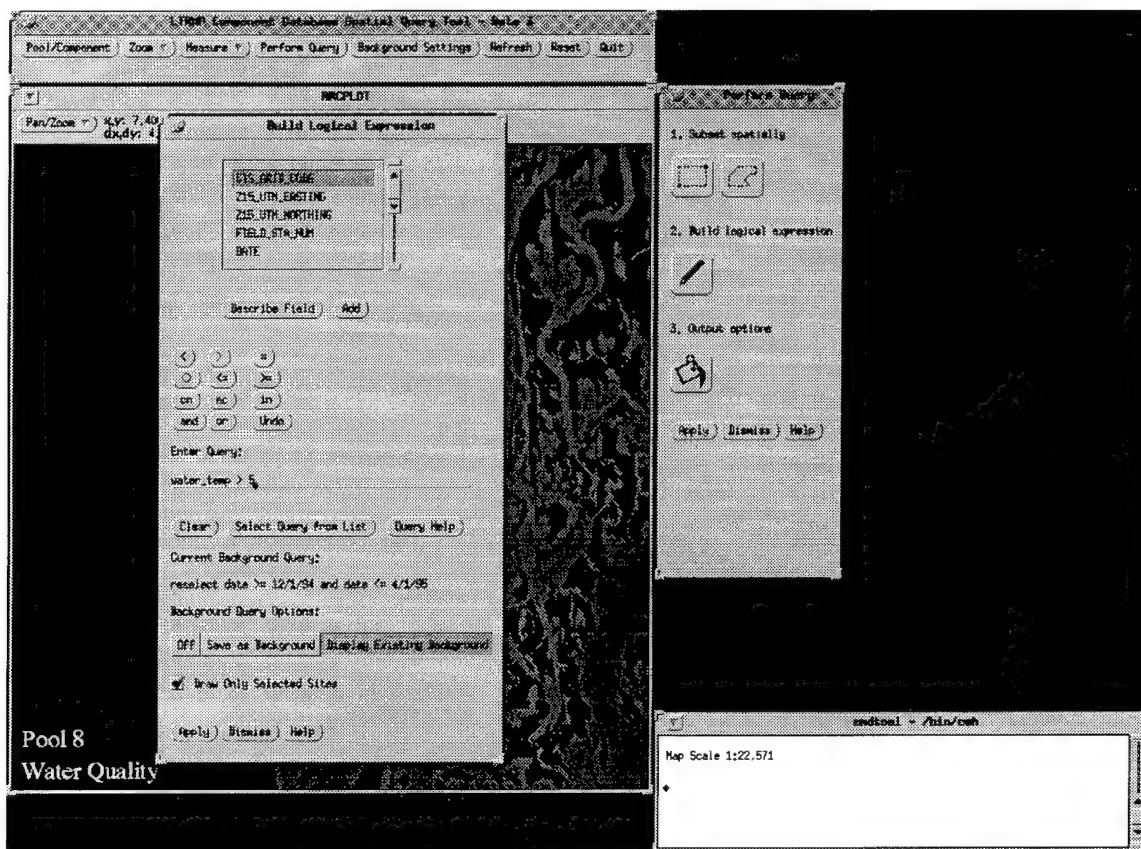**Figure 6.** Sites meeting background query criteria.

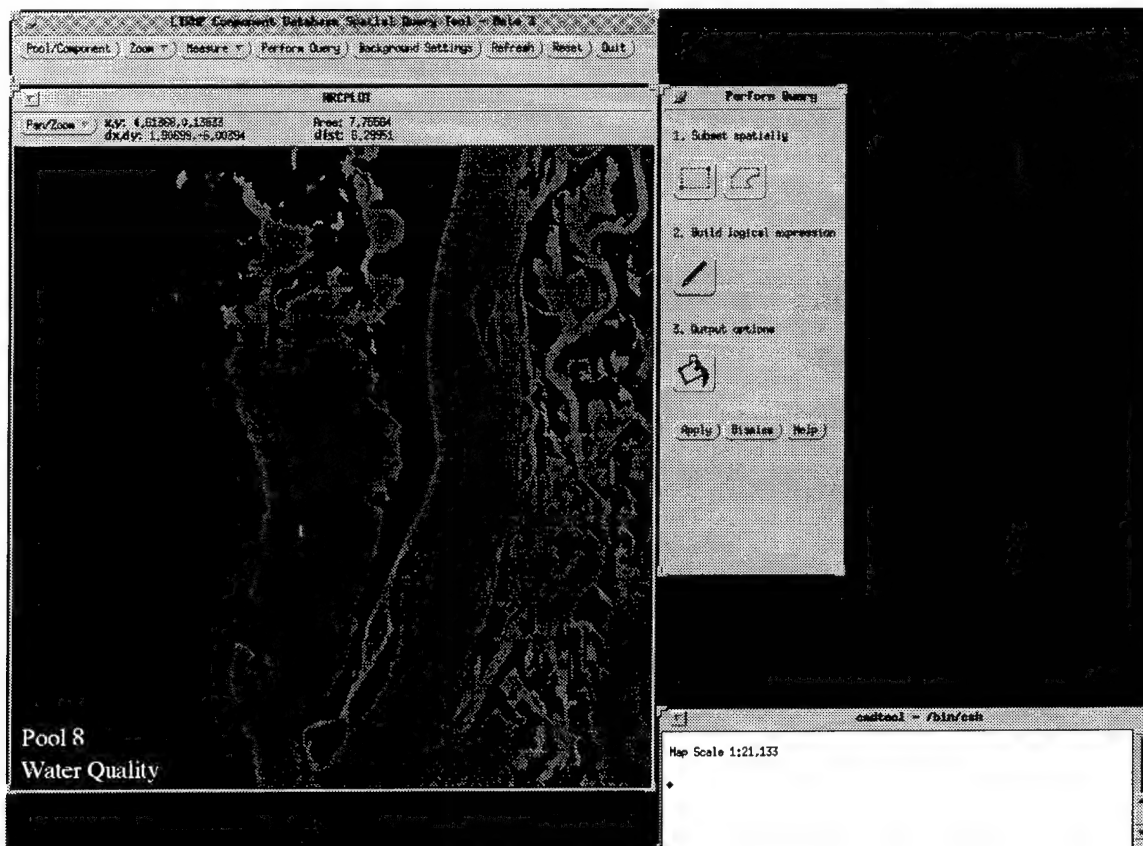**Figure 7.** Entering primary query.

Figure 8. Sites meeting background and primary query criteria.

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5. Select Output Options

If output options other than screen display are desired, select the "Output Options" icon from the Perform Query menu. The Output Options menu will be displayed with choices for map output or ASCII file output. Select one or both options and type in the desired filename without an extension (Figure 9). Output files will be written to the user_output directory with the naming convention:

> filename.ps (postscript file)
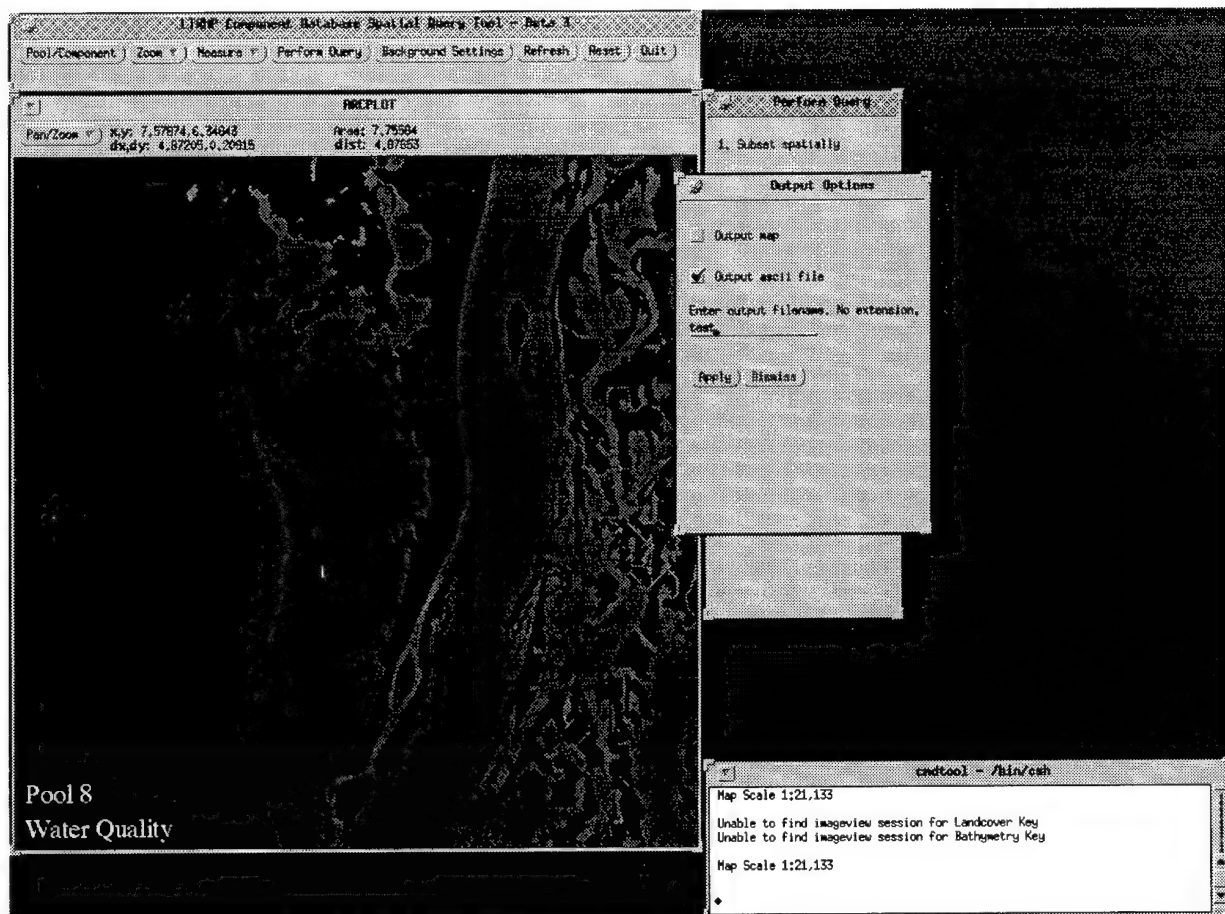> filename.txt (ASCII file)

Figure 9. Output options menu.

If the "Output map" option from the Output Options menu was selected, a secondary Map Options menu will be displayed. Select the desired map options and then select Apply. If the "Output ASCII file" option from the Output Options menu was selected, a secondary ASCII file output menu will be displayed. Select the items to be output to the ASCII file by highlighting the desired item in the scrolling list and selecting the add button (Figure 10). Select the "Apply" button when done defining output fields. To output all items, leave the output items entry line blank and select the "Apply" button. The ASCII file output will be comma-delimited with character items enclosed in single quotes (Figure 11). Note: The defined output options will remain set until specifically changed. Closing the Perforn Query menu, using the Zoom options, changing the spatial subset, or changing the logical expression will not alter the output options. Make sure to change filenames between runs to prevent overwriting existing files.

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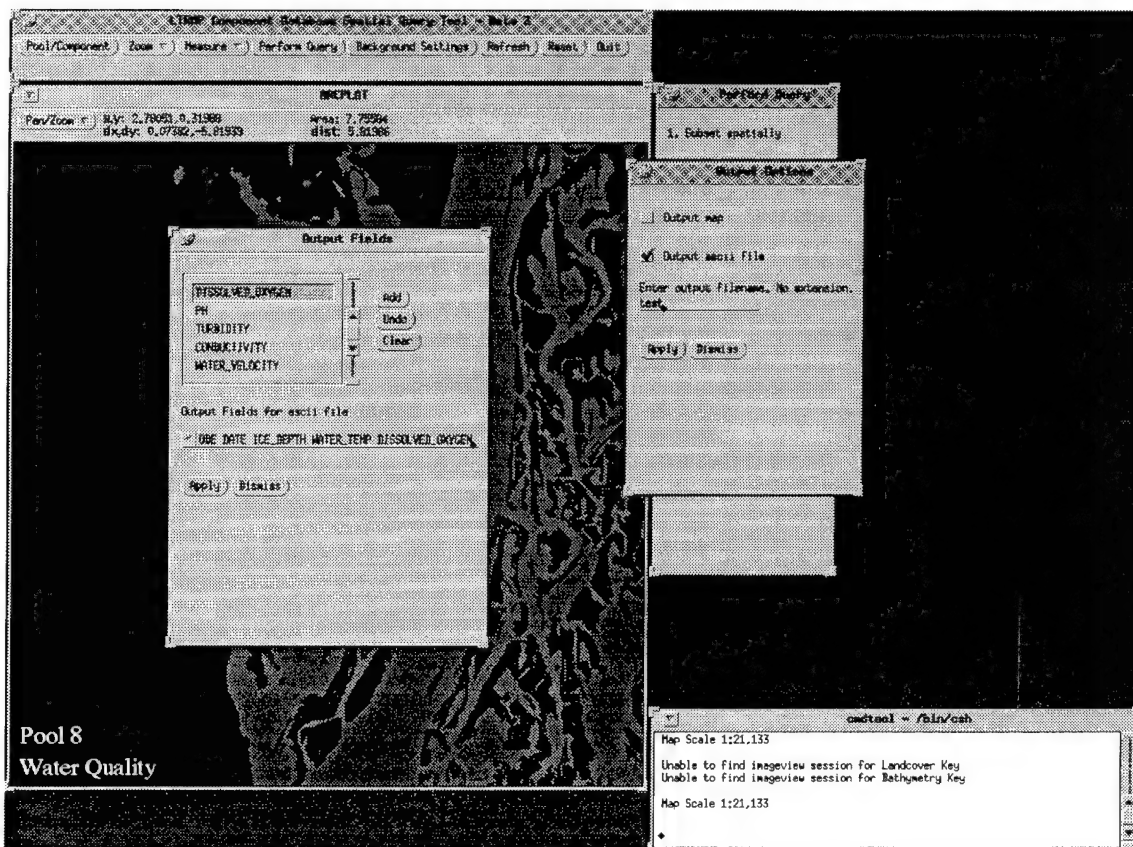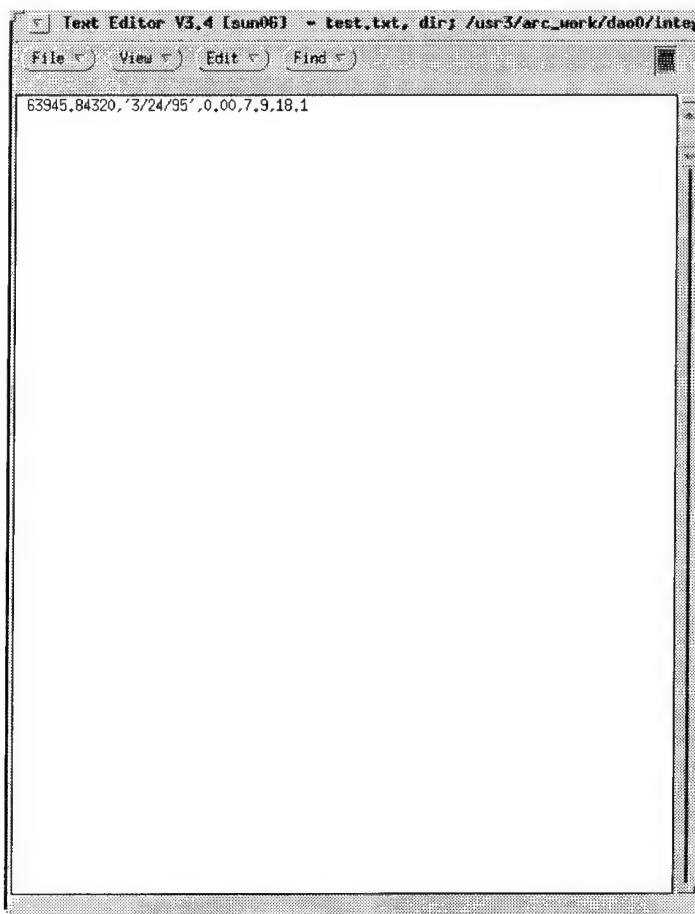**Figure 10.** Selecting fields to be output to an ASCII file.

Text Editor V3.4 [sun06] - test.txt, dir; /usr3/arc_work/dao0/inte

File ▽ View ▽ Edit ▽ Find ▽

63945.84320,'3/24/95',0.00,7.9,18.1

Figure 11. Example of output ASCII file.

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6. Submit Query

Select the "Apply" button from the Perform Query menu to apply the logical expression to the selected spatial subset of sampling sites, update the screen display, and output any selected output file types. After the program has executed, the screen will be refreshed, and the sampling sites meeting query criteria will be drawn in red and annotated with the number of times the site has been visited and met query criteria. The sites not meeting the query criteria will be drawn in white (Figure 6). If background query options have been set, the sites in the background query subset will be drawn in green, the sites meeting secondary query criteria will be drawn in red, and the sites not in the background query subset will be drawn in white. Note: When using background themes other than Land/Water, the sites will be drawn in colors appropriate to the selected theme (Figure 12).

Figure 12. Using background settings options to display bathymetry and structures.

Vegetation, land use, hydrology, and geomorphic characteristics vary significantly over the Upper Mississippi River System study area. When integrated with monitoring data, spatial databases can assist scientists in determining ecological status and trends and help explain causal relationships. This is the first in a series of tools that will facilitate the full integration of LTRMP monitoring databases with the wealth of spatial data now available for the Upper Mississippi River floodplain.

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Reference

U.S. Fish and Wildlife Service. 1993. Operating Plan for the Upper Mississippi River System Long Term Resource Monitoring Program. Environmental Management Technical Center, Onalaska, Wisconsin, Revised September 1993. EMTC 91-P002R. 179 pp. (NTIS #PB94-160199)

Appendix

Building Logical Expressions

Logical expressions have three components:

    Logical operands
    Logical operators
    Logical connectors

Logical operands include:

    The name of a field in a database table (e.g., STREAMS-ID)
    A constant numerical value (e.g., 10)
    A character string in single quotation marks (e.g., 'HIGH')

Logical operators include:

=	Operand-1 is equal to Operand-2
<>	Operand-1 is not equal to Operand-2
>=	Operand-1 is greater than or equal to Operand-2
<=	Operand-1 is less than or equal to Operand-2
>	Operand-1 is greater than Operand-2
<	Operand-1 is less than Operand-2
CN	Operand-1 contains the character string Operand-2 Character operands only (e.g., NAME CN 'MAIN')
NC	Operand-1 does not contain the character string Operand-2 Character operands only (e.g., NAME NC 'MAIN')
IN	Operand-1 is in the specified set of constants or character expressions. (e.g., CLASS IN [3,4,7,8] or TEXT IN ['a','b','c','d'])

Logical connectors include:

AND   For the condition to be evaluated as true, the logical expressions on both sides of the AND must be true.

OR   For the condition to be evaluated as true, the logical expression on one or the other side of the "OR" must be true. The condition will also be evaluated as true if both logical expressions are true.

The simplest logical expressions take the following form:

<operand-1> <logical operator> <operand-2>

For example:

CLASS < 8

Up to eight logical expressions of this simple form can be combined to form more complex expressions by using logical connectors; for example:

CLASS >= 2 AND CLASS <= 8 OR SUIT = 5

All logical operators and connectors have equal precedence. Operations are performed in sequence from left to right. However, parentheses can be used to request that logic within parentheses have the highest precedence.

NOTE: Each element of a logical expression (i.e., operand, logical operator, logical connector, parentheses) must be separated by blanks.

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The Environmental Management Technical Center stores point-sampled data for fisheries, water quality, and invertebrates in a relational database management system. These component data are collected at fixed and random sites in each of the key Long Term Resource Monitoring Program (LTRMP) study pools: 4, 8, 13, 26, and the open river reach on the Mississippi River; and the La Grange Pool on the Illinois River. While the geographic locations of these data are also collected and stored, the tools to automate the integration of these data with spatial data had not previously been developed. A need existed for an application that would facilitate spatial subsetting and visualization of the distribution of sites meeting certain query criteria. The LTRMP Component Database Spatial Query Tool is a Unix-based ARC/INFO ARC Macro Language application that integrates the component data with spatial data by taking advantage of the graphical display and query capabilities of ARC/INFO. The application features an easy-to-use graphical user interface and requires only very basic knowledge of Geographic Information Systems (GIS) to use effectively.

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